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*Observations, communicated to the Publisher by Mr. Antony van Leewenhoeck, in a Dutch Letter of the 9th of Octob. 1676. here English'd: Concerning little Animals by him observed in Rain- Well- Sea- and Snow-water; as also in water wherein Pepper had lain infused.*

**I**N the year 1675. I discover'd living creatures in Rain water, which had stood but few days in a new earthen pot, glased blew within. This invited me to view this water with great attention, especially those little animals appearing to me ten thousand times less than those represented by Monsr. Swamerdam, and by him called *Water-fleas* or *Water-lice*, which may be perceived in the water with the naked eye.

The *first* sort by me discover'd in the said water, I divers times observed to consist of 5, 6, 7, or 8 clear globuls, without being able to discern any film that held them together, or contained them. When these *animalcula* or living Atoms did move, they put forth two little horns, continually moving themselves: The place between these two horns was flat, though the rest of the body was roundish, sharpening a little towards the end, where they had a tayl, near four times the length of the whole body, of the thickness (by my Microscope) of a Spiders-web; at the end of which appear'd a globul, of the bigness of one of those which made up the body; which tayl I could not perceive, even in very clear water, to be mov'd by them. These little creatures, if they chanced to light upon the least filament or string, or other such particle, of which there are many in water, especially after it hath stood some days, they stook intangled therein, extending their body in a long round, and striving to dis-intangle their tayl; whereby it came to pass, that their whole body leapt back towards the globul of the tayl, which then rolled together Serpent-like, and after the manner of Copper- or Iron wire that having been wound about a stick, and unwound again, retains those windings and turnings. This motion of extension and contraction continued a while; and I have seen several hundreds of these poor little creatures, within the space of a grain of gross sand, lye fast cluster'd together in a few filaments.

I also discover'd a *second* sort, the figure of which was oval, and I imagined their head to stand on the sharp end. These were a little bigger than the former. The inferior part of their body is flat, furnished with divers incredibly thin feet, which moved

very

very nimbly, and which I was not able to discern till after several Observations. The upper part of the body was round, and had within, 8, 10, or 12 globuls, where they were very clear. These little Animals did sometimes change their figure into a perfect round, especially when they came to lye on any dry place. Their body was also very flexible; for as soon as they hit against any the smallest fibre or string, their body was bent in, which bending presently also yerked out again. When I put any of them on a dry place, I observ'd, that changing themselves into a round, their body was raised pyramidal-wise with an extant point in the middle, and having lain thus a little while with a motion of their feet, they burst asunder, and the globuls were presently diffus'd and dissipated, so that I could not discern the least thing of any film, in which the globuls had doubtless been inclosed: And at this time of their bursting asunder I was able to discover more globuls than when they were alive.

But then I observ'd a third sort of little Animals, that were twice as long as broad, and to my eye yet eight times smaller than the first. Yet for all this, I thought I discern'd little feet, whereby they moved very briskly, both in a round and streight line.

There was, further, a *fourth* sort, which were so small, that I was not able to give them any figure at all. These were a thousand times smaller than the eye of a big Loupe: For I judge, the *axis* of the eye of such a Loupe to be more than ten times as long as the axis of any of the said little creatures. These exceeded all the former in celerity. I have often observ'd them to stand still as 'twere upon a point, and then turn themselves about with that swiftness, as we see a Top turn round, the circumference they made being no bigger than that of a small grain of Sand; and then extending themselves streight forward, and by and by lying in a bending posture.

I discover'd also several other sorts of Animals, but these were very big respectively; of which I intend not to speak here; only this, that they were generally made up of such soft parts, as the former, they bursting asunder as soon as they came to want water.

#### *Observ. II.*

The 26. *May*, it rained hard; the rain growing less, I caused some of that Rain-water, running down from the house-top, to be gather'd in a clean Glass, after it had been washed two or  
three

three times with the water. And in this I observ'd some few very little living creatures, and seeing them, I thought they might have been produced in the leaden-gutters in some water, that had there remain'd before. *Observ. III.*

On the same day, the Rain continuing, I took a great Porcelain-dish, and expos'd it to the free Air upon a wooden vessel, about a foot and a half high, that so no earthy parts, from the falling of the Rain-water upon that place, might be spatter'd or dash'd into the said dish. With the first water that fell into the dish, I wash'd it very clean, and then flung the water away, and receiv'd fresh into it, but could discern no living creatures therein; only I saw many irregular terrestrial parts in the same.

The 30. of *May*, after I had, ever since the 26<sup>th</sup>, observ'd every day twice or thrice the same Rain-water, I now discover'd some, yet very few, exceeding little Animals, which were very clear.

The 31<sup>th</sup> of *May*, I perceiv'd in the same water more of those Animals, as also some that were somewhat bigger. And I imagine, that many thousands of these little Creatures do not equal an ordinary grain of Sand in bigness: And comparing them with a Cheese-mite (which may be seen to move with the naked eye) I make the proportion of one of these small Water-creatures to a Cheese-mite, to be like that of a Bee to a Horse: For, the circumference of one of these little Animals in water, is not so big as the thickness of a hair in a Cheese-mite

*Observ. IV.*

*June 9<sup>th</sup>*, having received, early in the morning, some Rain-water in a dish, as before, and pour'd it into a very clean Wine-glass, and expos'd it about 8 of the clock in the morning to the Air, about the height of the third story of my house, to find, whether the little Animals would appear the sooner in the water, thus standing in the Air:

Observing the same accordingly the 10<sup>th</sup> of *June*, I imagin'd, I saw some living creatures therein; but because they seem'd to be but very few in number, nor were plainly discernable, I had no mind to trust to this observation.

The 11<sup>th</sup> of the same month, seeing this water move in the Glass from a stiff gale of wind (which had blown for 36 hours without intermission, accompanied with a cold, that I could very well endure my Winter-cloaths,) I did not think, I should then perceive any living creatures therein; yet viewing it at-

tentively, I did, with admiration, observe a thousand of them in one drop of water, which were of the smallest sort, that I had seen hitherto.

The 12<sup>th</sup> of *June*, the wind being at west, the Sun shining with interloping clouds, I viewed the same Rain water, and found the fore-mention'd little Animals so plentifully in the water which I took up from the surface, that one or two thousand in one single drop did not make up their number.

The 13<sup>th</sup> of the same month, viewing the same water again, I found, besides the Animals already noted, a sort of creatures, that were eight times as big as they, of almost a round figure: And as those very small *animalcula* did swim gently among one another, moving like as Gnats do in the Air; so did these bigger ones move far more swiftly, tumbling round as 'twere, and then making a sudden downfall.

The 14<sup>th</sup> of *June* I did find these very little creatures in no smaller number. The 16<sup>th</sup>, I saw them as before; and this water, which had been, in all,  $\frac{1}{2}$  of a pint, being now more than half dried up, I flung it away. *Observ. V.*

The 9<sup>th</sup> of *June*, I put of the same Rain-water in a very clean Wine-glass in my Counter or Study, and viewing the same, I perceived no living creatures in it.

*Note*, that my Study stands toward the North-east, in my Anti-chamber, and is very close, joyned together with Wainscot, having no other opening than one hole of an inch and a half broad, and 8 inches long, towards the street furnished with 4 windows, of which the two lowermost open inwards, and by night are closed with two wooden Shuts; so that there comes in but little Air from without, unless it be that I use a candle in making my Observations, in which case I lift up a little Casement, that the steam of the candle may not offend me; but yet drawing a Curtain at that time over almost all the windows.

The 10<sup>th</sup> of *June*, observing the mentioned Rain-water, which now had stood 24 hours in my study, I noted some few very small living creatures, in which, by reason of their extream minuteness, I could see no figure, and among the rest I discover'd one that was somewhat greater, of an oval figure,

*Note*, that when I say, I have view'd the water, I mean, that I have view'd only 3, 4, or 5 drops of the water, which I also flung away.

The 11<sup>th</sup> of *June*, looking upon this water afresh, I saw the said little creatures again, but there were then but very few of them.

The 12<sup>th</sup>, I saw them as the day before ; besides, I took notice of one figured like a Muffel-shell, with its hollow-side downwards, & it was of a length equal to the eye of a louse.

The 13<sup>th</sup>, early, I discover'd the extream small creatures in greater number, and among them I saw a bigger one, as I did before. In the evening of the same day I saw the same very small insects again in no less number, taking notice, that the same had a transparent part standing out behind : I discover'd also some little animals which were somewhat longer than an oval, and these were about six times as big as the extream small creatures: Their head, which run out somewhat in length, they often drew in, and then appear'd to be almost round I perceived also some that were altogether round, and the *axis* of these was twice as long as that of the smallest creatures. These two greater sorts were very flexible, so that their body did bend at the touch of the least and finest filament.

The 14 of *June* I perceived the oval insects in greater plenty.

The 16. I saw them in yet greater numbers; and they were flat beneath, and round above ; and besides, I noted very small creatures, that were three times as long as they were broad: And divers other sorts, too long to describe here. And in the evening of the same day, I discover'd little feet in the small oval creatures, which were many in number ; as also a much bigger creature of the same figure, which was likewise furnished with legs. And here I gave over my Observations as to this water.

*Observ. VI.*

The 17<sup>th</sup> of this month of *June* it rained very hard ; and I caught some of that Rain-water in a new Porcelain dish, which had never been used before, but found no living creatures at all in it, but many terrestrial particles, and, among others, such as I thought came from the smoak of Smiths-coals, and some thin thrids, ten times thinner than the thrid' of a Silk-worm, which seem'd to be made up of globuls ; and where they lay thick upon one another, they had a green colour.

The 26<sup>th</sup>, having been eight days out of Town, and kept my Study shut up close, when I was come home and did view the said water, I perceived several *animalcula*, that were very small. And

herewith I desisted from making at this time any further Observations of Rain-water.

Mean time, this Town of *Delft* being very rich in water, and we receiving from the River of *Maase* fresh water, which maketh our water very good; I viewed this water divers times, and saw extream small creatures in it, of different kinds and colours; and even so small, that I could very hardly discern their figures: But some were much bigger, the describing of whose motion and shape would be too tedious: This only I must mention here, that the number of them in this water was far less than that of those, found in Rain-water; for if I saw a matter of 25 of them in one drop of this Town-water, that was much.

In the open Court of my house I have a well, which is about 15 foot deep, before one comes to the water. It is encompassed with high walls, so that the Sun, though in *Cancer*, yet can hardly shine much upon it. This water comes out of the ground, which is sandy, with such a power, that when I have laboured to empty the well, I could not so do it but there remained ever a foots depth of water in it. This water is in Summer time so cold, that you cannot possibly endure your hand in it for any reasonable time. Not thinking at all to meet with any living creatures in it, (it being of a good taste and clear) looking upon it in *Sept.* of the last year, I discover'd in it a great number of living animals very small, that were exceeding clear, and a little bigger than the smallest of all that I ever saw; and I think, that in a grain weight of this water there was above 500 of those creatures, which were very quiet and without motion.

In the Winter I perceived none of these little animals, nor have I seen any of them this year before the month of *July*, and then they appear'd not very numerous, but in the month of *August* I saw them in great plenty.

*July 27. 1676.* I went to the Sea-side, at *Schevelingen*, the wind coming from Sea with a very warm Sun-shine; and viewing some of the Sea-water very attentively, I discover'd divers living animals therein. I gave to a man, that went into the Sea to wash himself, a new Glass-bottle, bought on purpose for that end, intreating him, that being on the Sea, he would first wash it well twice or thrice, and then fill it full of the Sea-water; which desire of mine having been complied with, I tyed the bottle close with a clean bladder, and coming home, and viewing it, I  
saw

in it a little animal that was blackish, looking as if it had been made up of two globuls. This creature had a peculiar motion, after the manner as when we see a very little flea leaping upon a white paper; so that it might very well be called a Water-flea; but it was by far not so great as the eye of that little animal, which Dr. *Swammerdam* calls the Water-flea. I also discovered little creatures therein, that were clear, of the same size with the former animal which I first observed in this water, but of an oval figure, whose motion was Serpent-like. I took further notice of a third sort, which were very slow in their motion: Their body was of a Mouse-colour, clear towards the oval-point; and before the head, and behind the body there stood out a sharp little point angle-wise. This sort was a little bigger. But there was yet a fourth sort somewhat longer than oval. Yet of all these sorts there were but a few of each, so that in a drop of water I could see sometimes but three or four, sometimes but one.

*July 31.* after I had from the 27. of this month viewed this water every day, but perceived no little animals in it, looking upon it now, I saw an 100, where before I had seen but one; but these were of an other figure, and not only lesser, but they were also very clear, and of an oblong oval figure, only with this difference, that me thought their heads ended sharper: And although they were a thousand times smaller than a small grain of sand, yet I discern'd, that when they lay out of the water in a dry place, that they burst in pieces & spread into 3 or 4 very little globuls, and into some aqueous matter, without my being able to discern any other parts in them.

The 2<sup>d</sup> and 4<sup>th</sup> of *August* I saw many of the aforesaid small animals: but the 6<sup>th</sup> and 8<sup>th</sup>, I did not by far perceive so many of them as before. And those few ones I saw the 8<sup>th</sup>, were so very small, that even by my Microscope they were hardly discernible.

*Observations of water, wherein whole Pepper had layn infused several dayes.*

1. Having several times endeavoured to discover the cause of the pungency of *Pepper* upon our tongue, and that the rather, because it hath been found, that though *Pepper* had lain a whole year in vinegar, yet it retained still its pungency; I did put about  $\frac{1}{2}$  of an ounce of whole pepper in water, placing it in my Study, with this design, that the pepper being thereby rendred soft, I might be enabled the better to observe what I proposed



to my self. This pepper having lain about 3 weeks in the water, to which I had twice added some Snow-water, the other water being in great part exhaled; I looked upon it the 24. of *April*, 1676. and discern'd in it, to my great wonder, an incredible number of little animals, of divers kinds; and among the rest, some that were 3 or 4 times as long as broad; but their whole thickness did, in my estimation, not much exceed that of the hair of a Louse. They had a very pretty motion, often tumbling about and sideways; and when I let the water run off from them, they turned as round as a Top, and at first their body changed into an oval, and afterwards, when the circular motion ceased, they returned to their former length.

The 2<sup>d</sup> sort of creatures, discover'd in this water, were of a perfect oval figure, and they had no less pleasing or nimble a motion than the former; and these were in far greater numbers. And there was a 3<sup>d</sup> sort, which exceeded the two former in number; and these had tails also, like those I had formerly observ'd in Rain-water.

The 4<sup>th</sup> sort of creatures, which moved through the 3 former sorts, were incredibly small, and so small in my eye, that I judged, that if 100 of them lay one by another, they would not equal the length of a grain of coarse Sand; and according to this estimate, ten hundred thousand of them could not equal the dimensions of a grain of such coarse Sand.

There was discover'd by me a fifth sort, which had near the thickness of the former, but they were almost twice as long.

2. The 26<sup>th</sup> of *April*, I took 2½ ounces of Snow-water, which was about three years old, and which had stood either in my Cellar or Study in a Glass-bottle well stopped. In it I could discover no living creatures: And having poured some of it into a Porcelain Thea-cup, I put therein half an ounce of whole pepper, and so placed it in my Study. Observing it daily until the 3<sup>d</sup> of *May*, I could never discover any living thing in it; and by this time the water was so far evaporated, and imbibed by the pepper, that some of the pepper-corns began to lye dry. This water was now very thick of odd particles; and then I poured more Snow-water to the pepper, until the pepper-corns were cover'd with water half an inch high. Whereupon viewing it again the fourth and fifth of *May*, I found no living creatures in it; but the sixth, I did very many, and those exceeding small ones,

ones, whose body seem'd to me twice as long as broad; but they moved very slowly, and often round-ways.

The 7<sup>th</sup>, I saw them yet in far greater numbers.

The 10<sup>th</sup> I put more Snow-water to the pepper, because the former was again so exhale'd, that the pepper-corns began to be dry again.

The 13<sup>th</sup> and 14<sup>th</sup>, I saw the little creatures as before; but the 18<sup>th</sup>, the water was again so dry'd away, that it made me pour on more of it. And the 23<sup>th</sup>, I discover'd, besides the aforesaid little animals, another sort, that were perfectly oval, and in figure like Cuckow-eggs. Me thought, the head of them stood on the sharp end: Their body did consist, within, of 10, 12, or 14 globuls, which lay separate from one another. When I put these *animalcula* in a dry place, they then changed their body into a perfect round, and often burst asunder, & the globuls, together with some aqueous particles, spread themselves every where about, without my being able to discern any other remains. These globuls, which in the bursting of these creatures did flow asunder here and there, were about the bigness of the first very small creatures. And though as yet I could not discern any feet in them, yet me thought, they must needs be furnished with very many, seeing that the smallest creatures, which I said before to be very plentiful in this water, and lay sometimes more than an 100 of them on one of the oval creatures, were by the motion, made in the water by the great ones (though to my eye they seem'd to lye still) driven away by them, in the manner as we blow away a feather from our mouth. Of the same oval creatures I never could discover any very little ones, how attentive soever I was to observe them.

The 24<sup>th</sup> of May observing this water again, I found in it the oval little animals in a much greater abundance. And in the evening of the same day, I perceived so great a plenty of the same oval ones, that 'tis not one only thousand which I saw in one drop; and of the very small ones, several thousands in one drop\*.

\* This Phenomenon, and some of the following ones seeming to be very extraordinary, the Author hath been desir'd to acquaint us with his method of observing, that others may confirm such Observations as these.

The 25<sup>th</sup>, I saw yet more oval creatures: And the 26<sup>th</sup>, I found so vast a plenty of those oval creatures, that I believe, there were more than 6 or 8000 in one drop; besides the abundance of those very little animals, whose number was yet far greater.

This

This water I took from the very surface ; but when I took up any from beneath, I found that not so full of them by far. Observing, that these creatures did augment into vast numbers, but not being able to see them increase in bigness, I began to think whether they might not in a moment, as 'twere, be composed or put together : But this speculation I leave to others.

The 26<sup>th</sup> of *May* at night, I discern'd almost none of the little creatures, but saw some with tayls, of which I have spoken heretofore, to have seen them in Rain-water: But there drove in the water throughout an infinity of little particles, like very thin hair, only with this difference, that some of them were bent.

The 27<sup>th</sup> I perceived none at all of the little animals, but great number of the bigger. The 28<sup>th</sup>, all sorts of those living creatures in this peppery water were grown thinner. But the 30<sup>th</sup>, I saw very few living creatures in the water, and where I now saw but one, I had some days ago seen a hundred. And by this time the water was so dried away, that the pepper began to lye bare. And then I fill'd my Thea-dish with Snow-water again.

*June* 1. the living creatures appear'd again in so great abundance, as I had ever seen before; but, as to those very small ones, I cannot say that I saw them. Those I saw, I could now discern to be furnish't with very thin legs, which was very pleasant to behold.

The same day I discover'd a few of the very small creatures, which were almost 8 times as big as the smallest of all. These had such a swift motion through the others, that 'tis incredible. Those bigger animals, that were about 8 times smaller than the eye of a Louse, were in no smaller number.

3. *May* the 26<sup>th</sup>, I took about  $\frac{1}{3}$  of an ounce of whole pepper and having pounded it small, I put it into a Thea-cup with  $2\frac{1}{2}$  ounces of Rain-water upon it, stirring it about, the better to mingle the pepper with it, and then suffering the pepper to fall to the bottom. After it had so stood an hour or two, I took some of the water, before spoken of, wherein the whole pepper lay, and wherein were so many several sorts of little animals ; and mingled it with this water, wherein the pounded pepper had lain an hour or two, and observed, that, when there was much of the water of the pounded pepper, with that other, the said animals soon died, but when little, they remained alive.

*June* 2. in the morning, after I had made divers Observations since the 26<sup>th</sup> of *May*, I could not discover any living thing, but  
saw

saw some creatures, which tho they had the figures of little animals, yet could I perceive no life in them, how attentively soever I beheld them.

The same day at night, about 11 a clock, I discover'd some few living creatures: But the 3<sup>d</sup> of June I observed many more which were very small, but 2 or 3 times as broad as long. This water rose in bubbles, like fermenting beer.

The 4<sup>th</sup> of June in the morning I saw great abundance of living creatures; and looking again in the afternoon of the same day, I found great plenty of them in one drop of that water, which were no less than 8 or 10000, and they looked to my eye, through the Microscope, as common sand doth to the naked eye. On the 5<sup>th</sup>, I perceived, besides the many very small creatures, some few (not above 8 or 10 in one drop) of an oval figure, whereof some appear'd to be 7 or 8 times bigger than the rest.

The 6<sup>th</sup>, those animals were as before; but the 8<sup>th</sup>, the oval animals were increased in number, swimming among the said very small creatures; and now they were all very near of one and the same bigness. The 9<sup>th</sup>, the oval creatures appear'd yet in greater numbers, but the very small ones, in less number; and now, using a particular method in observing, I noted, that the feet, wherewith the animals were furnish'd, did plainly move, & that with an incredible swiftness: And me thought, that now & then I saw, that the globuls, of which I said that the greatest part of their body was made up, were not perfectly round, but that every one of them had a prominent point. These creatures were, to my eye, eight times smaller than the eye of a Loufe.

*Some new Observations made by Sig. Cassini and deliver'd in the Journal des Scavans, concerning the two Planets about Saturn, formerly discover'd by the same, as appears in N. 92. of these Tracts.*

One of these 2 Planets, which is distant from the Center of Saturn 10 diameters and a half of his Ring, maketh his revolution about Saturn in 80 days. He was discover'd at the Parisian Observatory, A. 1671. about the end of Oct. and in the beginning of Nov. in his greatest Occidental digression, and after many cloudy days he ceased to appear, for a reason which was then unknown, but hath been discover'd since. For, after that many revolutions of this small Planet had been observ'd, he was found to have a period of apparent Augmentation & Diminution, by which period he becomes visible in his greatest Occidental digression, and invisible in his greatest Oriental digression.

It is certain, that this vicissitude of Augmentation and Di-